INITIAL HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

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Chesapeake Energy Center CCR Surface Impoundment: Bottom Ash Pond

Submitted To: Chesapeake Energy Center
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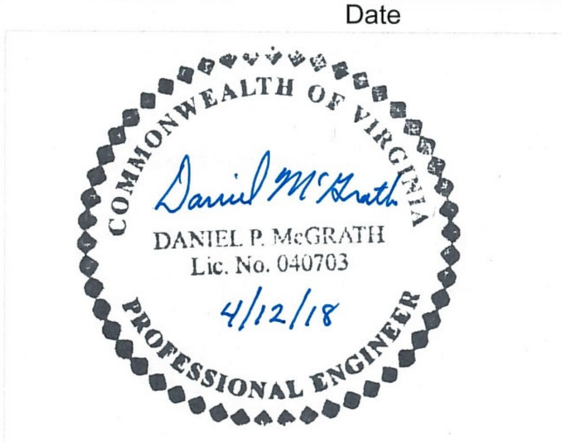
1.0 CERTIFICATION

This Initial Hazard Potential Classification Assessment for the Chesapeake Energy Center's Bottom Ash Pond was prepared by Golder Associates Inc. (Golder). The document and Certification/Statement of Professional Opinion are based on and limited to information that Golder has relied on from Dominion Energy and others, but not independently verified, as well as work products produced by Golder.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.73(a)(2) of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 [40 CFR §257.73(a)(2)], as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

Daniel McGrath	Associate and Senior Consultant
Print Name	Title
Daniel McGrath	4/12/18
Signature	Date



2.0 INTRODUCTION

This Initial Hazard Potential Classification Assessment was prepared for the Chesapeake Energy Center's (CEC) inactive Coal Combustion Residuals (CCR) surface impoundment known as the Bottom Ash Pond (BAP). This Hazard Potential Classification Assessment was prepared in accordance with 40 CFR Part §257, Subpart D and is consistent with the requirements of 40 CFR §257.73(a)(2) and 40 CFR §257.100(e)(3)(v).

CEC, owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion), is located in the City of Chesapeake, Virginia at 2701 Vepco Street. The station includes an inactive CCR surface impoundment, the BAP, as defined by the Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule and Direct Final Rule (40 CFR §257; the CCR rule).

This analysis details the purpose, data sources, method of analysis, and development of a map showing the inundation level expected downstream during a breach event of the BAP dam at CEC. The inundation areas were compared with various map sources to determine what, if any, effect on downstream structures could be expected from a breach of the impounding structure. This evaluation covers the current condition of the pond.

3.0 PURPOSE

This certification is required under 40 CFR §257.73(a)(2) and 40 CFR §257.100(e)(3)(v), regarding the hazard potential classification assessment of the BAP at CEC. The purpose of this analysis is to recommend a hazard potential classification for the BAP dam at CEC.

Sources of data used in the analysis included:

1) United States Geological Survey (USGS) topographical map (Norfolk South quad sheet 2013);
2) Statistical rainfall data from NOAA Atlas 14 (NOAA's Precipitation Frequency Data Server);
3) Maps and aerial photos of area roads and structures from the Google Earth Pro;
4) Aerial survey of the CEC landfill performed by H&B Surveying and Mapping, LLC, dated July 2015;
5) Flood map information from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Community Panel # 5100340024D dated 12/16/2014. (Accessed through ArcGIS – FEMA's National Flood Hazard Layer mapping system);
6) Web Soil Survey 2.1, Natural Resources Conservation Service (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm);
7) Hurricane Storm Surge Map, City of Chesapeake (http://gisweb.cityofchesapeake.net/slosh/);
8) Ground survey of the Bottom Ash Pond performed by D&M Surveying, dated January 15, 2018

4.0 ASSESSMENT

4.1 Description of the Impounding Structure

The CEC BAP is located on a peninsula of land bounded on the east side by the Southern Branch of the Elizabeth River, on the west side by the CEC's discharge canal, and on the south by low lying wetland areas. The BAP embankment is approximately 25 feet wide at the top and has a top elevation of approximately 20 feet above mean sea level (AMSL). The BAP typically does not retain water and has been without a permanent pool of water since the CEC ceased coal-fired operations in 2014. The upstream slopes vary from 3:1 to 2:1 and downstream slopes vary from 2.5:1 to 2:1. The downstream toe is approximately at elevation 1, giving an effective embankment height of 19 feet. The toe of the eastern slope is reinforced with a sheet pile retaining wall.

This study has been developed based on the existing BAP topography as of January 15, 2018. The primary outlet structure is currently a 30-inch diameter Corrugated High Density Polyethylene (CHDPE) pipe that drains to the adjacent sediment basin. There currently is no auxiliary spillway. See Figure 1 for an aerial photo of the BAP dam.

This report has been prepared with the hydraulic models depicting the existing topography and outlet culvert as described in this section.

4.2 Drainage Area and Hazard Analysis Area Descriptions

The drainage area for the BAP consists mainly of grass areas (landfill cover soils) that are presumed to be in good condition for purposes of determining a Runoff Curve Number (CN) as defined by the Natural Resource Conservation Service (NRCS). The soils in the drainage area are primarily Hydrologic Soil Group C. The largest portion of the contributing drainage is from the landfill, with drainage areas consisting of the landfill intermediate cover slopes and the top covered with a geomembrane rain cover. Table 1 below outlines the drainage areas and NRCS curve numbers used in this analysis.

Table 1: Bottom Ash Pond Contributing Drainage Areas

Area Description	Area, Acres	CN
Landfill Cover - grass, good, HSG C	18.94	varies
BA Pond	4.16	79
Total Drainage Area	23.10	

The pond discharges directly into the adjacent sedimentation basin through a 30-inch diameter culvert in the western embankment. South of the dam are low-lying wetland areas, and east of the dam is the Southern Branch of the Elizabeth River. There are no occupied structures downstream of the dam.

4.3 Method of Analysis

To model the inflows into and out of the impoundment, a numerical model was created using the Hydraulic Engineering Center's Hydrologic Modeling System (HEC-HMS) Version 4.2.1 to generate the anticipated runoff hydrograph from the 24-hour, 1,000-year storm event. Table 2 outlines the resulting inflow and outflow for the non-breach scenario analysis.

Table 2: 1,000-Yr Storm Event and Flows

Storm Event	Rainfall (in)	Peak Inflow (cfs)	Peak Outflow (cfs)	Max Water Elevation (ft)	Inflow Volume (ac-ft)
24-hr, 1,000-Yr	14.6	309.9	41.0	19.04	19.75

For the impounding structure failure analysis, the dam breach routine within HEC-HMS was used to model the failure event and produce the resulting outflow hydrograph. Input values were provided for the embankment geometry, stage-storage relationship, development time, and trigger elevation. The storm-related failure was triggered when the water level in the pond was at its peak.

Due to the simplicity of the downstream geometry, numerical modeling of the breach outflow was not performed. Instead, a general discharge map was generated. Due to the basin's proximity to the Elizabeth River, the entire area downstream of the bottom ash pond (west, south and east directions) is subject to flooding from the 1% annual chance event (100-Yr event) and is classified as Zone AE on the Flood Insurance Rate Map (FIRM) (reference 6). The elevation given on the FIRM in the area of the basin (8.5 feet AMSL) indicate floodwater levels in the Elizabeth River and Deep Creek would overtop the low-lying wetland areas; however, the basin would not be overtopped (El 20). This is important to note since the storm event used in this analysis is much larger in magnitude than the 1% annual chance event that would cause flooding in the water bodies adjacent to the BAP. The FIRM is included as Figure 2 of this report. A breach of the BAP is not anticipated to impact the CEC or any other developed areas.

4.4 Failure Analysis Scenarios

A breach simulation during the 1,000-year event was conducted to examine the potential downstream impacts of a possible impounding structure failure. In this, the peak outflow in cubic feet per second (cfs) and the maximum high water level downstream was estimated. The breach failure at the 1,000-year event is assumed to be a piping failure through the embankment and not due to overtopping. The breach location was chosen to be in the southern embankment, discharging to the surrounding wetlands and 100-Yr floodplain, as a breach in the eastern embankment into the Elizabeth River would not affect downstream land. The embankment between the BAP and the sedimentation basin is constructed of cemented ash materials and is highly erosion resistant; therefore, a breach event into the sedimentation basin was not evaluated.

A “sunny day” breach is assumed to occur due to piping of soils through the embankment when the water level in the reservoir is at its normal pool elevation; however, there typically is not a normal pool in the BAP so this evaluation was not performed. A seismic analysis was not performed, nor were other sudden failure type scenarios considered as this evaluation is for the potential downstream impacts due to an embankment breach during the design storm event (1,000-yr event).

4.5 Hydraulic Modeling Results

The downstream flood models for the failure scenarios are presented in Table 3. Due to the small magnitude and short flow path for the breach events, detailed hydraulic modeling of the breach outflow was not performed.

Table 3: Summary of Peak Discharges, 1,000-Yr Event

Scenario	Peak Discharge (cfs)	Outflow Volume (ac-ft)
No Breach	41.0	14.01
Breach Event	226.6	18.52

4.6 Downstream Consequences

The modeled embankment failure scenarios may cause erosion damage to the downstream side of the embankment leading to wetland areas/Deep Creek. The effect of the inflow into the Deep Creek/Elizabeth River confluence is anticipated to be minimal, due to the short duration of the flow event and the relatively small volume of the breach flow in comparison to the normal volume of flow in the river.

4.7 Spillway Adequacy

If a structural embankment failure does not occur, the existing 30-inch diameter culvert will adequately pass the 1,000-yr event. At its peak during the 1,000-year event, the basin has approximately 0.96 feet of freeboard. The adjacent sedimentation basin is also capable of receiving the design storm event discharge without overtopping.

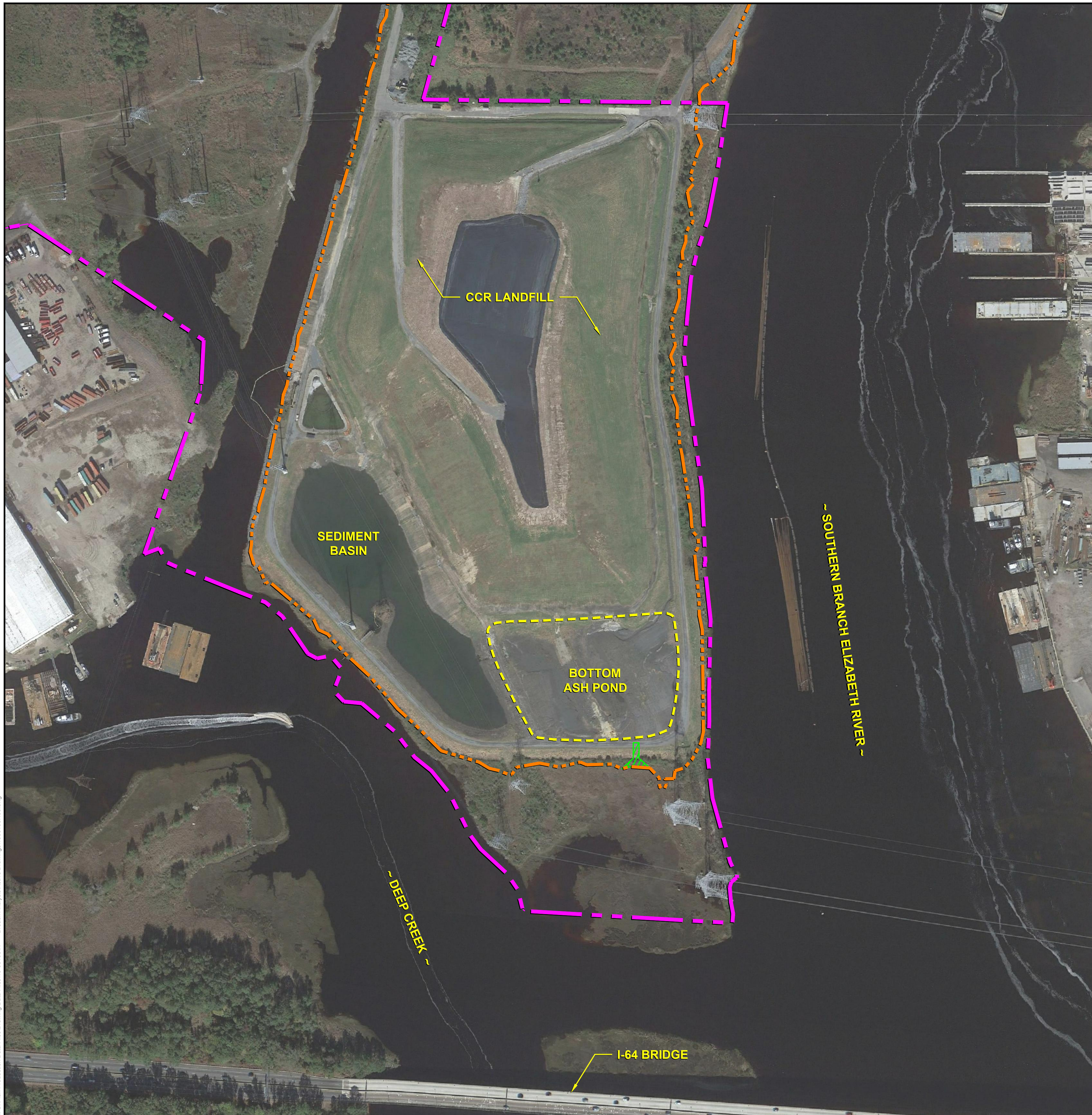
5.0 HAZARD CLASSIFICATION

Pursuant to 40 CFR §257.73, a CCR unit is classified as a **Significant Hazard Potential** where failure or mis-operation of the dam results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant Hazard Potential classification dams are often located in predominantly rural or agricultural areas, but could be located in areas with population and significant infrastructure. The potential inundation zone downstream of the BAP dam embankment does not contain occupied structures, nor is it regularly occupied by plant personnel.

6.0 CONCLUSIONS

The results of this analysis show a breach of this impounding structure during a storm event has no downstream impacts to manmade structures, and failure or mis-operation of the dam is unlikely to result in loss of human life. Therefore, the BAP dam in its current condition is assigned a hazard potential rating of "Significant" as defined under 40 CFR §257.73.

APPENDIX A - Figures



LEGEND

- AREA SUBJECT TO FLOOD FLOW AND VELOCITY
- 100 YEAR FLOOD PLAIN BOUNDARY (ZONE AE)
- PROPERTY LINE
- BOTTOM ASH POND LIMITS

NOTES

1. MAPPING OF FLOODED AREAS AND FLOOD WAVE TRAVEL TIMES ARE APPROXIMATE. TIMING AND EXTENT OF ACTUAL INUNDATION MAY DIFFER FROM INFORMATION PRESENTED ON THIS MAP.
2. THE PROPERTY BOUNDARY SHOWN ON THIS DRAWING IS AS SUBMITTED BY H & B SURVEYING AND MAPPING, LLC., DECEMBER 19, 2014.
3. 100 YEAR FLOOD PLAIN BOUNDARY TAKEN FROM PHOTOGRAMMETRIC AERIAL SURVEY PERFORMED ON 07/10/2015 BY MCKENZIE SNYDER, INC.
2. BASE MAP CONSISTS OF GOOGLE EARTH AERIAL IMAGE DATED 11/05/2016 RETRIEVED ON 01/24/2018.

300 0 300
FEET
SCALE

CLIENT
DOMINION ENERGY

CONSULTANT
Golder Associates

YYYY-MM-DD 2018-01-25
DESIGNED DPM
PREPARED ABR
REVIEWED
APPROVED

PROJECT
CHESAPEAKE ENERGY CENTER
DCR INVENTORY #00441
CHESAPEAKE, VIRGINIA

TITLE
BOTTOM ASH POND
1,000-YEAR EVENT BREACH FLOW

PROJECT NO. 13-00193
REV. 0
FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: G:\Plan Production Data Files\Drawing Data Files\13-00193H - Breach Analysis\Active Drawings\1300193H05.dwg

National Flood Hazard Layer FIRMette

FEMA

36°45'56.82"N

76°18'27.06"W

76°17'48.09"W

36°45'26.84"N

Feet

0 250 500 1,000 1,500 2,000

1:6,241.13

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth
- Regulatory Floodway *Zone AE, AO, AH, VE, AR*

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/7/2018 at 11:26:11 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Figure 2

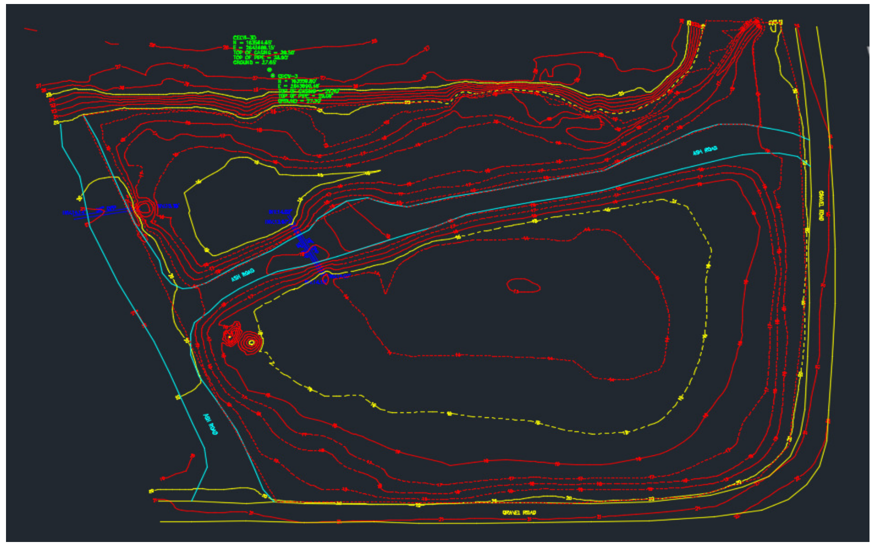
APPENDIX B

Bottom Ash Pond Hydraulic Modeling Analysis

Chesapeake Energy Center - Bottom Ash Pond
HEC-HMS Input Tables

BAP - North Section

ELEVATION	AREA (SF)	AREA (AC)
15	5067	0.12
16	13,341	0.31
17	20,928	0.48
18	28,572	0.66
19	36,436	0.84



BAP - South Section

ELEVATION	AREA (SF)	AREA (AC)
13	203	0.0047
14	20901	0.48
15	45858	1.05
16	64,500	1.48
17	77,178	1.77
18	84,547	1.94
19	92,312	2.12
20	153,740	3.53

Combined Sections stage storage

ELEVATION	AREA (SF)	VOLUME, ft^3	AC-FT	TOTAL
20	153,740	141,059	3.24	12.89
19	128,748	120,849	2.77	9.66
18	113,119	105,523	2.42	6.88
17	98,106	87,778	2.02	4.46
16	77,841	63,909	1.47	2.44
15	50,925	34,817	0.80	0.98
14	20,901	7,721	0.18	0.18
13	203	0	0	0

Drainage Areas for Partial Excavation

Area Description	Size, Ac.	CN	H_L	Slope, ft/ft	T_L, min	Drains to
Top Rain Cover	3.246	98	873	0.01	8.10	RR Channel
North Slope	5.496	61	335	0.131	3.71	East Channel
East Slope	8.206	61	297	0.145	3.20	East Channel (half)
South Slope	1.994	61	363	0.118	4.16	BA Pond
BA Pond Proper	4.157	79	120	0.075	1.32	Self

Drainage Areas for Sediment Basin

Area Description	Size, Ac.	CN	H_L	Slope, ft/ft	T_L, min	Drains to
West Slope	8.03	61	297	0.145	3.20	West Channel
Sed Basin Proper	6.41	77	120	0.075	1.40	Self

Assumed k for bottom ash:	0.005	cm/s
Pond floor constant (q):	1.64E-04	CFS/ft2

30" CPP Rating	
Elevation	Q out (CFS)
14	0
15.15	0
15.25	0.1
15.5	0.60
15.75	2.00
16	3.80
16.25	6.20
16.5	8.80
16.75	11.70
17	15.10
17.25	18.70
17.5	22.50
17.75	26.20
18	29.60
18.25	32.70
18.5	35.50
18.75	38.10
19	40.60
19.25	42.90
19.5	45.00
19.75	47.10
20	49.00

Pond Floor*
Q out (CFS)
0
0.831
0.831
0.831
0.831
2.189
2.189
2.189
2.189
3.433
3.433
3.433
3.433
4.687
4.687
4.687
4.687
5.977
5.977
5.977
5.977
5.977

*pond floor area = only northern section area due to road

Sediment pond elevation-area as of 1/15/18

ELEVATION	AREA (SF)	AREA (ACRES)
10	142,846	3.28
11	158,617	3.64
12	169,987	3.90
13	180,322	4.14
14	191,892	4.41
15	201,158	4.62
16	210,383	4.83
17	219,732	5.04
18	229,705	5.27
19	242,218	5.56
20	279,160	6.41

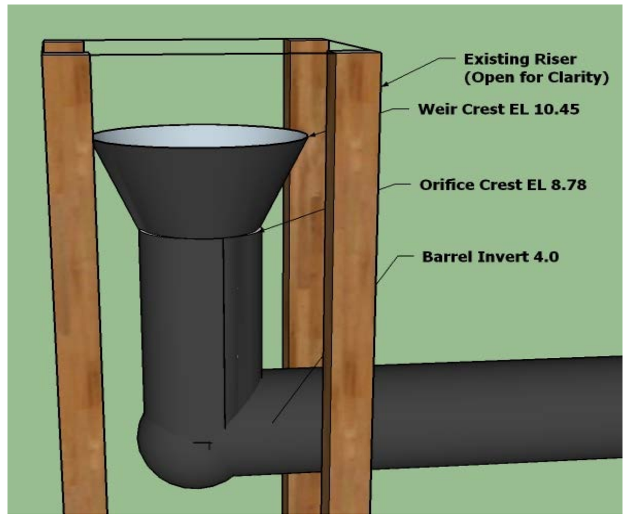
CEC Existing Stormwater Basin Riser

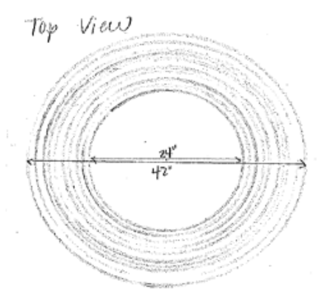
Weir 1 elevation	10.45
Weir 1 length	11
Orifice 1 area	9.62
Weir discharge coefficient	3.3
Orifice discharge coefficient	0.6

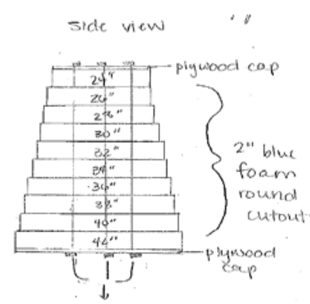
Culvert Outlet from UD culvert:

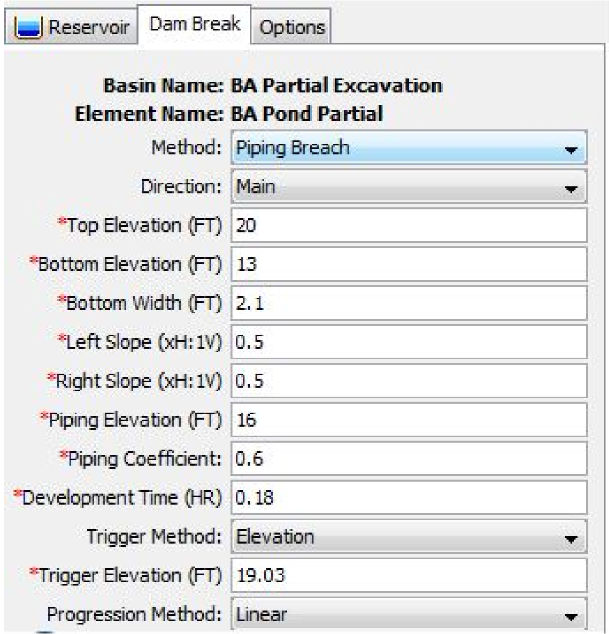
Inv in	4	
Inv out	-2.1	
Length	129	
Dia	21	inches (24" SDR-17 HDPE)
Slope	0.0473	
Tw El	2	

Elevation	Weir 1	Orifice 1	Min	Culvert	Rating
10.45				0.00	0.00
10.5	0.41	0.05	0.05	35.80	0.05
10.75	5.96	0.79	0.79	36.60	0.79
11	14.81	1.96	1.96	37.40	1.96
11.25	25.97	3.45	3.45	38.20	3.45
11.5	39.06	5.18	5.18	38.90	5.18
11.75	53.80	7.14	7.14	39.70	7.14
12	70.05	9.29	9.29	40.40	9.29
12.25	87.66	11.63	11.63	41.10	11.63
12.5	106.55	14.13	14.13	41.80	14.13
12.75	126.62	16.80	16.80	42.50	16.80
13	147.81	19.61	19.61	43.20	19.61
13.25	170.08	22.56	22.56	43.90	22.56
13.5	193.36	25.65	25.65	44.50	25.65
13.75	217.61	28.86	28.86	45.20	28.86
14	242.80	32.21	32.21	45.80	32.21
14.25	268.89	35.67	35.67	46.40	35.67
14.5	295.86	39.24	39.24	47.10	39.24
14.75	323.68	42.93	42.93	47.70	42.93
15	352.31	46.73	46.73	48.30	46.73
15.25	381.74	50.64	50.64	48.90	48.90
15.5	411.95	54.64	54.64	49.50	49.50
15.75	442.92	58.75	58.75	50.10	50.10
16	474.62	62.96	62.96	50.60	50.60
16.25	507.05	67.26	67.26	51.20	51.20
16.5	540.18	71.65	71.65	51.80	51.80
16.75	574.01	76.14	76.14	52.30	52.30
17	608.51	80.72	80.72	52.90	52.90
17.25	643.68	85.38	85.38	53.40	53.40
17.5	679.50	90.13	90.13	54.00	54.00
17.75	715.96	94.97	94.97	54.50	54.50
18	753.06	99.89	99.89	55.00	55.00
18.25	790.77	104.89	104.89	55.60	55.60
18.5	829.09	109.97	109.97	56.10	56.10
18.75	868.01	115.14	115.14	56.60	56.60
19	907.52	120.38	120.38	57.10	57.10
19.25	947.61	125.70	125.70	57.60	57.60
19.5	988.28	131.09	131.09	58.10	58.10
19.75	1029.51	136.56	136.56	58.60	58.60
20	1071.30	142.10	142.10	59.10	59.10

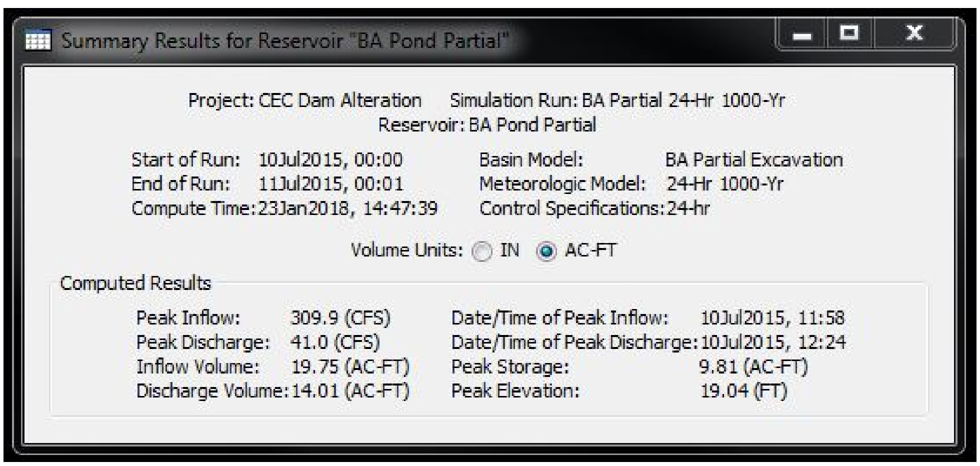




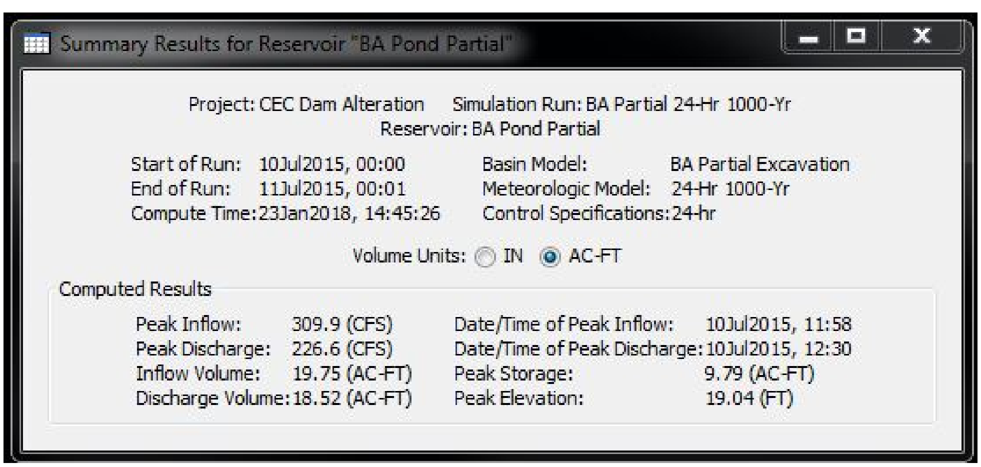




HEC-HMS Breach Parameters



HEC-HMS Summary Output, non-breach



HEC-HMS Summary Output, breach event

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